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SPECIFICATION FOR BREATHING APPARATUS

PART IV ESCAPE BREATHING APPARATUS (SHORT DURATION SELF-CONTAINED TYPE)

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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PART IV ESCAPE BREATHING APPARATUS (SHORT DURATION SELF-CONTAINED TYPE)

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Indian Standard

SPECIFICATION FOR BREATHING APPARATUS

PART IV ESCAPE BREATHING APPARATUS (SHORT DURATION SELF-CONTAINED TYPE)

0. FOREWORD

0.1 This Indian Standard (Part IV) was adopted by the Indian Standards Institution on 29 July 1982, after the draft finalized by the Industrial Safety Advisory Committee had been approved by the Executive Committee.

0.2 Breathing apparatus enables a person to remain in irrespirable and poisonous atmosphere for long or short periods and still to retain his full physical and mental capacity. It is also known as rescue apparatus, anti-gas apparatus, respirator, smoke helmet and gas mask. The apparatus is required in mines, gas-works, chemical factories, iron works, steel plants, smelting and metallurgical works, oil refineries and oil tankers. It may also be used by fire brigade, municipality, army, navy and air force personnel, and mountaineers.

0.3 Breathing apparatus should be of such efficiency and reliability as to ensure safety in toxic gases, oxygen-deficient atmosphere, extreme heat, high humidity, and wreckage and falls during disaster. It is, therefore, imperative that breathing apparatus should have an appropriate design, efficiency and safety under various conditions including temperature; resistance; quality of materials; and workmanship. Besides, it should ensure chemical purity of air/oxygen breathed and pass rigorous physiological, physical, chemical and mechanical tests. Those are prescribed in this standard which is being issued in the following four parts:

a) *Part I* — Closed-circuit breathing apparatus in which the exhaled air is rebreathed by the wearer after the carbon dioxide concentration has been affectively reduced and the oxygen concentration enriched. It is used either with a full facepiece or with mouthpiece and nose clip;

b) *Part II* — Open-circuit breathing apparatus in which compressed air carried in cylinders is fed through a demand valve and breathing tube to a full face piece. Exhaled air passes through a non-return valve to the atmosphere.

NOTE — Both these types of breathing apparatus are categorized as self-contained breathing apparatus.

c) *Part III* — Fresh air hose and compressed air line breathing apparatus designed to enable a person to work in irrespirable and hazardous atmospheres for longer periods than are generally possible by self-contained breathing apparatus. These may be without blower, with hand blower and with motor operated blower; and compressed air line may be of constant flow type or demand type; and

d) *Part IV* — Escape breathing apparatus which is a self-contained, short duration type, breathing apparatus designed for the sole purpose of enabling a person to escape from a work area in the presence of dangerous dusts, gases, fumes or vapours. It may be of the open circuit or closed circuit type.

0.3.1 Reference should be made to IS : 9623-1980* for guidance on the type of respiratory protection that should be provided for particular conditions.

0.3.2 In addition, care should be taken in the choice of escape breathing apparatus of short-duration type where such equipment is to be kept and used in a very high (45 + 3°C) or very low (− 6 + 3°C) ambient temperature it should be noted that the duration for the use of the apparatus particularly open-circuit apparatus, will be reduced in pressures greater than atmosphere.

0.4 The breathing apparatus covered by this standard should never be used to provide protection in normal work situations. It is essential to ensure that the time necessary to allow wearers to escape is within the capacity of the apparatus provided.

0.5 Assistance has been derived in preparing this standard from BS 4667 : Part 4 – 1975 Specifications for breathing apparatus: Part 4 Escape breathing apparatus, and is gratefully acknowledged, issued by the British Standards Institution.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Recommendations for the selection, use and maintenance of respiratory protective devices.

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard prescribes requirements for the design, construction and performance of escape breathing apparatus (short duration, self-contained) of open-circuit types using a source of compressed air, and closed-circuit types using a source of compressed oxygen. Laboratory and practical tests are included for the assessment of compliance of apparatus with the requirements.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 8347-1977* and those given below shall apply.

2.1 Escape Breathing Apparatus — Simple short duration self-contained apparatus for escape purposes. These are of two types:

a) *Open-Circuit Escape Breathing Apparatus* — Apparatus in which compressed air carried in cylinders, or other approved containers, is fed through a demand valve (or other device which adequately controls the air supply) and breathing tube to a full facepiece or to a mouthpiece and noseclip. Exhaled air passes through a non-return valve to the atmosphere.

b) *Closed-Circuit Escape Breathing Apparatus* — Apparatus in which compressed oxygen is carried in cylinders and the exhaled air is re-breathed by the wearer after the carbon dioxide concentration has been effectively reduced and the oxygen concentration enriched. It is used with a full facepiece or with a mouthpiece and noseclip.

2.2 Nominal Duration

a) *Open-Circuit Apparatus* — The period of time in minutes arrived at by dividing the fully charged capacity of the cylinder or other approved container in litres by 32 (that is, assuming an air flow of 32 l/minute).

b) *Closed-Circuit Apparatus* — The time in minutes arrived at by dividing the fully charged capacity of the cylinder or other approved container in litres by the flow of oxygen into the apparatus in litres per minute.

NOTE — An air flow of 32 l/min is appropriate to the work rate of a man walking at a steady speed of 6·5 km/h. In practice, the time for which protection is afforded may be longer or shorter than the nominal duration and will depend upon the work rate and physical characteristics of the wearer.

*Glossary of terms relating to respiratory protective devices.

2.3 Inhaled Air — The atmosphere breathed in by the wearer.

2.4 Exhaled Air — The atmosphere breathed out by the wearer.

3. REQUIREMENTS

3.1 Method of Operation

3.1.1 *Open-Circuit Compressed Air Breathing Apparatus* — The apparatus is designed and constructed to enable the wearer to breathe air on demand from a high pressure air cylinder or user approved container via a lung-governed demand valve or other device which adequately controls the air supply, connected to the facepiece or mouthpiece. The exhaled air passes from the facepiece or mouthpiece through a non-return outlet valve to the atmosphere.

3.1.2 *Closed-Circuit Breathing Apparatus* — The apparatus is designed and constructed so that exhaled air passes from a facepiece or mouthpiece through a breathing tube into a purifier containing chemicals. In the compressed oxygen type, the chemicals in the canister absorb exhaled carbon dioxide. The oxygen and purified air mix are fed to the wearer who inhales from a breathing bag; any excess gas is released through a relief valve.

3.2 Materials

3.2.1 All materials used in the construction shall have adequate mechanical strength, durability and resistance to deterioration by heat or contact with sea water/mine water. Such materials shall be anti-static and fire resistant as far as practicable.

NOTE — It is important that care is taken in selecting materials that may come into contact with high-pressure oxygen.

3.2.2 Exposed parts of the apparatus shall not be made of magnesium, litanium, aluminium or alloys containing such proportions of these metals as will, on impact, give rise to frictional sparks capable of igniting flammable gas mixtures.

3.2.3 Materials that may come into contact with the skin shall be non-staining, soft, pliable and shall not contain known dermatitic substances.

3.3 Strength and Resistance to Water — The apparatus shall be sufficiently robust to withstand the rough usage it is likely to receive in service and designed so that it will continue to function satisfactorily if temporarily submerged in water.

NOTE — In the case of closed circuit apparatus, some deflation of the breathing bag may occur due to the automatic opening of the relief valve.

3.4 Separation of Parts — The design and construction of the apparatus shall permit its component parts to be readily separated for cleaning, examination and testing. The couplings required to achieve this shall be readily connected and secured, where possible by hand. Any means for sealing used shall be retained in position when the joints and couplings are disconnected during normal maintenance.

3.5 Adjustable Parts — All parts requiring manipulation by the wearer shall be readily accessible and easily distinguishable from one another by touch. All adjustable parts and controls shall be constructed so that their adjustment is not liable to accidental alteration during use.

3.6 Leak Tightness — The apparatus shall be so designed and constructed as to prevent ingress of the external atmosphere within the limits set out in this standard.

3.7 Use as an Air Line Breathing Apparatus — If the escape breathing apparatus is designed to be used as a compressed air line apparatus having an emergency air supply for escape purposes, it shall comply with requirements of this standard.

3.8 Facepiece — Where facepieces are used, they shall be designed to meet the requirements given below.

3.8.1 The component parts, including any breathing tube between the facepiece and the demand valve, or other device which adequately controls the air supply, shall withstand a test under water at an air pressure of 1·7 kN/m² and shall be proved free from leakage.

3.8.2 Facepiece shall cover the eyes, nose, mouth and chin and shall provide adequate sealing on the face of wearer of the breathing apparatus against the outside gas, when the skin is dry or moist, when the head is moved and when the wearer is speaking.

3.8.3 The fit of the facepiece against the contours of the face shall be such that when tested in accordance with Appendix A, the inward leakage of the test contaminant between the facepiece and the wearer's face shall not exceed a value of 0·05 percent of the inhaled air for any one of the ten test subjects. Facepieces are not suitable for persons with beards. Unless special fabrications are made they will also not be suitable for wearer's with spectacles having side arms. In such situations mouthpiece with nose-clip should be preferred.

3.8.4 Facepiece shall be light in weight and comfortable to wear. The weight shall be symmetrically balanced to ensure the maximum retention of the face seal and to minimise muscular strain, particularly when worn in circumstances involving vigorous movements.

3.8.5 Facepieces shall have suitable and, preferably, replaceable eyepieces or eyeshields. Eyepieces or eyeshields shall be made of non-splinterable, clear and non-inflammable material.

3.8.6 Facepieces shall be secured to the face by means of an adjustable and replaceable head harness and they shall be fitted with a strap to support them when not being worn.

3.8.7 Means for speech transmission shall be incorporated.

3.8.8 The manufacturer shall provide means to reduce misting of the eyepieces or eyeshields in order that vision is not interfered with when the apparatus is tested in accordance with Appendix C.

3.8.8.1 The dead space in the facepiece shall be as low as possible.

3.8.8.2 The facepiece shall give wide field of vision.

3.8.8.3 Where manual wipers are provided in the facepiece, they shall be effective, durable, easy to operate and should not hit the eyebrow of the wearer.

3.9 Head Harness — The head harness shall hold the facepiece or mouthpiece firmly and comfortably in position and it shall be simply fitted and shall be capable of ready cleaning and decontamination. Any fabric used in the construction of a head harness shall be resistant to shrinkage and shall not cause any irritation to the skin of the wearer. The head harness strap shall be slip proof and durable.

3.10 Mouthpiece — If the apparatus is fitted with a mouthpiece it shall be designed to provide a reliable seal with the mouth and shall be secured against accidental displacement by means of a suitable head harness. It shall not be possible to close the orifice of the mouthpiece by pressure. It is recommended that a plug or cover be provided to close the orifice of the mouthpiece when not in use.

3.11 Noseclip — A noseclip shall be provided if mouthpiece is used and should be designed to afford maximum security against accidental displacement: it should not slip when the nose becomes moist with perspiration, and suitable means shall be provided for attaching it to the apparatus to prevent loss. The design of the noseclip shall be such so as to afford reasonable comfort to the wearer throughout the effective use of the apparatus.

3.12 Supporting Harness — The supporting harness shall be designed to allow the user to don the apparatus quickly, easily and securely without assistance.

3.13 Valves

3.13.1 *Closed-Circuit Apparatus* — If the circuit contains both inhalation and exhalation valves, it shall not be possible to an inhalation and valve assembly in the expiratory circuit or an exhalation valve assembly in the inspiratory circuit.

3.13.1.1 *Relief valve* — Breathing apparatus of the closed-circuit type shall be provided with a relief valve operated automatically by the pressure in the breathing circuit and designed so that inward leakage of the external atmosphere shall not exceed 0·002 5 percent when the moist valve is tested in accordance with Appendix D. The relief valve, which shall include an additional non-return valve, shall be protected against dirt and mechanical damage. Means shall be provided for sealing the relief valve to permit leak testing.

3.13.1.2 The relief valve shall have the following performance characteristics:

a) The opening pressure of the moist relief valve measured at a constant flow rate of 1 l/min shall be between 15 mm H_2O and 40 mm H_2O in any position of the valve.

b) The flow resistance at a constant flow of 300 l/min of that part of the expiratory breathing circuit between the relief valve and the breathing bag shall be not greater than the minimum opening pressure of the relief valve [measured as in (a)].

c) The resistance of the relief valve to an air flow of 50 l/min shall not exceed 75 mm H_2O in any position of the valve.

3.13.2 *Open-Circuit Apparatus*

3.13.2.1 *Exhalation valve* — The apparatus shall be provided with an exhalation valve to allow the escape of exhaled air and of any excess air delivered by the air supply, and it shall be operated automatically by the pressure in the breathing circuit.

3.13.2.2 The exhalation valve shall be so designed that inward leakage of the external atmosphere shall not exceed 0·002 5 percent when the moist valve is tested in accordance with Appendix D. The valve shall be protected against dirt and mechanical damage.

3.13.2.3 The exhalation valve shall be shrouded or shall include an additional non-return valve or other device that may be necessary to comply with **3.13.2.2**.

3.13.2.4 The design of the exhalation valve assemblies shall be such that valve discs or the assemblies can be readily replaced.

3.14 Flexible Hoses and Tubes

3.14.1 Any flexible hose or tube connected to the facepiece or mouthpiece shall permit free head movement and shall not restrict or close off the air supply under chin or arm pressure.

3.14.2 High pressure tubes and couplings shall be capable of withstanding, without damage, a test pressure of twice the maximum designed working pressure. It shall not be possible to fit a low pressure hose into part of the circuit having a higher pressure.

3.15 Pressure Gauge

3.15.1 Apparatus in which compressed air or oxygen is supplied from a cylinder shall have a pressure gauge incorporating a suitable blow-out release so that in the event of an explosion or fracture of the pressure elements of the gauge, the blast will be away from the front. If a window is incorporated it shall be of non-splintering glass or of clear plastic material.

3.15.2 If no main valve is fitted to a cylinder, the pressure gauge shall record the cylinder pressure at all times.

3.15.3 The pressure gauge shall be placed to enable the gas cylinder pressure to be read conveniently by the wearer.

3.15.4 The pressure gauge (*see* IS : 3624-1966* and IS : 8457-1977†) shall withstand pressure greater than the maximum cylinder pressure so that it will operate continuously and accurately without overstrain. Pressure gauge for use with such apparatus shall be shockproof.

3.16 Gas Cylinders and Main Valve

3.16.1 Gas cylinders and the valves fitted thereto shall comply with the provisions of *Gas Cylinder Rules*, 1981, as amended from time to time. Other containers shall be of approved types.

3.16.2 The main valve when fitted shall be of a suitable design and shall be designed that the full pressure in the gas cylinder cannot be applied rapidly to other parts of the apparatus.

*Specification for bourdon type pressure and vacuum gauges.
†Specification for type pressure gauges for automobiles (pocket type).

3.16.3 The valve shall be so designed that the valve spindle cannot be completely unscrewed from the assembly during normal operation of the valve.

3.17 Containers — If supplied in a container intended for storage, the apparatus shall be easily removed from it when required to be used.

3.18 Duration

3.18.1 Open-circuit apparatus shall have a nominal capacity of not less than 400 litres at working pressure.

3.18.2 Closed-circuit apparatus shall have a nominal duration of not less than 45 minutes.

3.18.3 In view of short durations, audible warning devices are not necessary.

3.19 Condition of the Inhaled Air

3.19.1 *Oxygen Content* — When closed-circuit apparatus is tested in accordance with Appendix C, the oxygen content of the inhaled air shall not fall below 21 percent (by volume).

3.19.2 *Carbon Dioxide Content* — When tested in accordance with Appendicis B and C, the carbon dioxide content of the inhaled air (including dead space effects) shall not exceed 2·0 percent (by volume).

3.20 Resistance to Breathing — Neither the inspiratory nor the expiratory side of the circuit shall have a dynamic resistance greater than 100 mm H_2O water gauge when tested at a flow of 40 litre/min in accordance with Appendix B.

3.21 Comfort — When tested in accordance with Appendix C, the apparatus shall be such that it is worn without avoidable discomfort and with little impediment to movement.

4. INSTRUCTIONS

4.1 Breathing apparatus manufactured in compliance with this standard shall be supplied accompanied by instructions for maintenance and use, which shall include where appropriate:

a) Nominal duration;

b) Guidance on fit of facepiece, and adjustment of faceseal where relevant;

c) A warning that adequate protection may not be provided by the apparatus in certain highly toxic atmospheres and that guidance should be sought from IS : 9623-1980*, and

d) A warning that allowance should be made for the fact that it is likely faceseal fit will not be suitable for persons wearing spectacles or having side burns or beards.

5. MARKING

5.1 Breathing apparatus manufactured in compliance with this standard shall be marked with the following particulars:

5.1.1 *Markings on the Facepiece*

a) Name, trade-mark or other means of identification of the manufacturer, and

b) Size (if more than one size is available).

5.1.2 *Markings on the Apparatus*

a) Name, trade-mark or other means of identification of the manufacturer;

b) Nominal duration of the apparatus; and

c) Year and month of manufacture on breathing bags, breathing tubes, mouthpiece, facepiece and diaphragm shall be marked legibly.

5.1.3 The facepiece and apparatus shall be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standard Institution (Certification Mark) Act, and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification mark may be granted to manufacturers or producers, may be obtained from the Indian Standards Institution.

*Recommendations for the selection, use and maintenance of respiratory protective devices.

APPENDIX A

(*Clause* 3.8.3)

TEST FOR INWARD LEAKAGE OF FACEPIECE

A-1. TEST SUBJECTS

A-1.1 Ten clean shaven persons are selected, covering a broad spectrum of facial characteristics (excluding significant abnormalities). It is to be expected that, exceptionally, some persons cannot be satisfactorily fitted with a full facepiece; such exceptional subjects are not used for testing facepieces.

A-2. FACEPIECES

A-2.1 If more than one size of facepiece is manufactured, each test subject is supplied with the appropriate size.

A-3. TEST PROCEDURE

A-3.1 Each test subject wearing the facepiece under test, complete with breathing tubes, is enclosed in a plastics hood which is loosely tied around his waist and around the breathing tube so that leakage is minimized. The inside of the hood is maintained at a pressure not more than 3 mm H_2O above atmospheric by supplying pure argon to the interior of the hood. (By preliminary inflation of the hood with argon and then by adjusting the argon supply when the hood has been fitted the atomsphere surrounding the facepiece is maintained at the concentration obtained from the argon cylinder.)

A-3.2 Each subject walks on a treadmill at 6·5 km/l while separately carrying out various head movements and reciting the alphabet.

A-3.3 The subject inhales through a breathing tube from a lung-governed oxygen supply and exhales through a breathing tube and a sampling bladder to atmosphere. The amount of argon in the expired gas is determined using for example a mass spectrometer and compared with the argon present within the hood to obtain the facepiece leakage.

APPENDIX B

(*Clauses* 3.19.2, 3.20 *and* D-1.1)

LABORATORY PERFORMANCE TEST

B-1. TEST EQUIPMENT

B-1.1 A breathing machine designed to provide sinusoidal air flows and operating at a rate corresponding to 20 respirations per minute.

B-2. TEST PROCEDURE

B-2.1 The machine delivers to the complete apparatus under test a tidal volume of 2 litres of a 5 percent (by volume) carbon dioxide/air mixture at a temperature of 37°C and fully saturated, the total delivery being 40 litres/min. The test is to run continuously for a period equal to the nominal duration of the apparatus.

B-2.2 In a separate test the sinusoidal air flow is increased to 100 litres/min for a period sufficient for an assessment to be made of the functioning of the apparatus at this flow rate.

B-2.3 In the case of closed-circuit apparatus in which the material used for absorbing carbon dioxide is contained in a canister or carbon cartridge, the laboratory test is made on the apparatus after the purifier has been subjected for 3 min to simulated rough usage as follows. The canister or cartridge are placed in a tray and arranged so that each has a movement of 6 mm. The tray is then subjected to a horizontal reciprocating motion at a rate between 185 cycles/min and 190 cycles/min with a stroke amplitude of 83 mm.

APPENDIX C

(*Clauses* 3.8.8, 3.19.1, 3.19.2 *and* 3.21)

PRACTICAL PERFORMANCE TEST

C-1. TEST SUBJECTS

C-1.1 Breathing apparatus is tested by two test subjects who must be trained in the use of breathing apparatus and who have been recently examined medically and certified fit to undertake the test procedure. Each subject is in normal clothing.

C-2. MEDICAL ATTENTION

C-2.1 The tests must be carried out under the supervision of a registered medical practitioner.

C-3. PREPARATION OF APPARATUS TO BE TESTED

C-3.1 In apparatus using compressed oxygen, the high pressure cylinders are purged with oxygen before being charged. A sample of the compressed oxygen is analysed for oxygen content and the flow of oxygen into the apparatus is measured. After the purifier is charged and the apparatus assembled, the resistance to breathing is measured. The apparatus with the cylinders charged to the prescribed pressure and ready for use is then tested for leak tightness.

C-3.2 In apparatus using compressed air, the high pressure cylinder is purged with air before being fully charged to the prescribed pressure. The apparatus is assembled, the resistance to breathing is measured and the apparatus is tested for leak tightness.

C-4. TEST PROCEDURE

C-4.1 The test subject, each wearing the apparatus being tested, walk at a steady 6·5 km/l on a level course and climb up and down a vertical ladder with a 460 mm square opening around the ladder.

C-4.2 Each test is continuous, without removal of the apparatus, for a period equal to the duration of the apparatus. At the end of the test, cylinder pressures are measured and the doctor takes such clinical observations as he considers necessary. At the end of each test, the test subjects are medically examined. The apparatus is examined for leak tightness, oxygen/air flow, resistance to breathing, excessive wear of parts and physical damage.

APPENDIX D

(*Clause* 3.13.1.1)

TEST FOR INWARD LEAKAGE OF RELIEF VALVE

D-1. TEST EQUIPMENT

D-1.1 A leak-tight box connected by a tube to a breathing simulator. A flow of test gas is maintained through the box. An instrument capable of measuring the concentration of the test gas. The breathing simulator is as specified in Appendix B, operating at flow of 40 litres/min with a back pressure of 50 mm H_2O.

D-2. TEST PROCEDURE

D-2.1 The valve under test is fitted in the box with a suitable adopter. On the expiration stroke the valve opens and air passes into the bag containing the test gas. On the inspiration stroke the valve closes and any slip or leakage of the valve allows test gas to pass into the inspiratory air stream; this air is monitored for test gas concentration; the difference in concentrations at this point end at a suitable reference point allows the slip and leakage of the valve to be circulated. The test is run for sufficient time to obtain a steady reading of the test gas concentration in the inspiratory air stream.

(*Continued from page 2*)

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SHRI N. C. MUKHERJEE	National Safety Council, Bombay
SHRI N. RAGHAVAN (*Alternate*)	
DR M. PANCHOLY	National Physical Laboratory (CSIR), New Delhi
SHRI C. PEREIRA	Joseph Leslie & Co, Bombay
SMT C. LESLIE REY (*Alternate*)	
SHRI S. G. RANADE	Directorate General of Ordnance Factories, Calcutta
SHRI S. S. SALODKAR	Coal India Ltd, Calcutta
SHRI S. D. SHROFF	Pradeep Safety Pvt Ltd, Bombay
SHRI M. D. SHROFF (*Alternate*)	
SHRI D. K. SIRKAR	Synthetics and Chemicals Ltd, Bareilly
SHRI P. R. SURENDRANATHAN	Directorate General Factory Advice Service and Labour Institutes (Ministry of Labour), Bombay
SHRI M. K. MALHOTRA (*Alternate*)	
SHRI FRANCIS LESLIE VAZ	Francis Leslie & Co, Bombay
SHRI HEATHCLIFF VAZ (*Alternate*)	

Panel for Respiratory Protective Equipment, ISAC/S-2/P1

Convener	
DR A. K. GHOSH	Central Mining Research Station, (CSIR), Dhanbad
Members	
SHRI R. N. MUKHERJEE (*Alternate* to Dr A. K. Ghosh)	
SHRI S. C. BATRA	Directorate General of Mines Safety, Dhanbad
SHRI A. C. CHAKRABORTY	Rerolle Burn Ltd, Howrah
SHRI B. GUHA NEOGI (*Alternate* I)	
SHRI H. N. BANNERJEE (*Alternate* II)	

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Members	*Representing*
SHRI D. M. DHAR	Steel Authority of India (Durgapur Steel Plant)
SHRI SHIV KUMAR (*Alternate*)	
SHRI DURGESH CHANDRA	Century Rayon, Kalyan
SHRI JAYANT ADHIA (*Alternate*)	
SHRI A. N. INDURKAR	Mines Safety Appliances Ltd, Calcutta
SHRI M. MISHRA (*Alternate*)	
SHRI P. P. JAIN	Mines Services Corporation, Asansol
SHRI A. P. AGARWALA (*Alternate*)	
SHRI S. C. KALE	Directorate General Factory Advice Service and Labour Institutes, Bombay
SHRI M. K. MALHOTRA (*Alternate*)	
SHRI C. PEREIRA	Joseph Leslie & Co, Bombay
SMT W. L. PEREIRA (*Alternate* I)	
SMT C. L. REY (*Alternate* II)	
SHRI S. D. SHROFF	Pradeep Packagers, Bombay
SHRI M. D. SHROFF (*Alternate*)	
SHRI HEATHCLIFF VAZ	Francis Leslie & Co, Bombay
SHRI FRANCIS VAZ (*Alternate*)	